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21 January 2016

Professor Roy Green
Chairman
Queensland Competition Authority
Level 27, 145 Ann Street
Brisbane, QLD, 4000

By email: electricity@qca.org.au

Dear Professor Green,

CANEGROWERS submission to QCA Regulated Retail Price Determination 2016-17

Thank you for the opportunity to make a submission to QCA's regulated retail electricity price determination review for 2016–17.

CANEGROWERS seeks the introduction of an electricity pricing system and tariff structure that mirror those resulting from a competitive market structure. Prices and tariffs should provide performance incentives, encourage reductions in cost across the supply chain and enable electricity users, particularly those in the traded goods sector, to remain internationally competitive.

Supporting inflated asset values, unrealistically high returns on those assets and unsustainable levels of investment in an underused network, Queensland's fundamentally flawed electricity pricing framework is failing the Queensland economy. It is threatening the viability and international competitiveness of irrigated agriculture across the state and putting jobs in regional communities at risk as local businesses contract and services are withdrawn.

The sharp increases in electricity prices that have occurred in recent years are unsustainable for both electricity network service providers (NSPs) and for electricity users alike.

- Ergon and Energex operate their networks at levels will below capacity, with growth in actual electricity consumption falling well below predicted levels. This is particularly the case for areas of Ergon's network that supply electricity for use in irrigated sugarcane production. Ergon's network investments are driven by the needs of urban and industrial users, not by the needs of irrigated agriculture.
- With energy prices worldwide at their lowest levels in many years, the impact of inflated electricity prices on the international competitiveness of irrigated agriculture and the associated rural and regional communities in Queensland remains a significant concern.

Transitional and Obsolete tariffs

There is a strong case for the treatment of irrigation as a separate customer class and for the continuation of a suite of electricity tariffs for use in food and fibre production.

As input to Ergon's tariff structure statement and the Australian Energy Regulator's (AER) review of that statement, CANEGROWERS commissioned an independent analysis using Ergon data to better understand the impacts and opportunities that these proposed tariffs present for Queensland's irrigators. The **attached** report prepared by the Alternative

Technology Association's (ATA) Energy Projects Team is part of a project funded by Energy Consumers Australia.

ATA's key findings are that:

- Cane growers will be better off with optional location specific 'cost reflective' pricing options that are targeted at particular irrigation types.
- Ergon Energy's proposed 'top 4 energy days' is actually preferable to a conventional peak demand charge (Max ½ hourly kW demand) for some irrigators.
- Opportunities for cane growers to load shift are materially improved for many 'winch' and 'pivot' irrigators if Ergon Energy's proposed 10-hour summer peak period is shortened (to 5 hours).
- Tariffs with demand charges impact irrigators adversely if they cannot shift load.
- Critical Peak Pricing and Peak Time Rebates are effective tools to enable all cane growers, including furrow irrigators, to share the benefits of reducing peak load on the network.

ATA found that in its view there is a clear case for there to be a range of network tariffs available that reflects the different demands irrigators place on the network compared to other users. The report identified the interruptibility of furrow irrigation during critical peak periods and the ability of winch and low pressure overhead irrigation systems to be operated in off-peak times. These characteristics support the following irrigation tariff structures:

- Critical peak pricing – which could provide an incentive for furrow irrigators to switch off loads during critical peak summer days.
- Peak and off-peak pricing:
    - Peak – daily peak pricing period of no more than 5 hours.
    - Off-peak – all other times with tariffs low enough to provide an incentive to load shift and not subject to 'any-time' peak demand charges (such as the off-peak demand charge proposed by Ergon).

As noted, Ergon's network investment over the past decade has been driven by urban and industrial demand, not the needs of irrigators. As the ATA analysis shows, consistent with the national electricity rules, truly cost reflective pricing would take account of the different pressures different user groups place on the network and contain pricing structures designed to influence usage patterns be designed to optimise the existing network. The report strongly supports CANEGROWERS call for a suite of tariffs for irrigation use. We are committed to working with Ergon to achieve this outcome ahead of the Queensland Competition Authority's 2016-17 regulated retail electricity price determination.

Escalation factor – Transitional and Obsolete Tariffs

In making its final retail electricity price determination for 2013-14 QCA adopted a general approach of:

a) escalating the charges in each transitional and obsolete tariff based on the percentage increase in the charges in the standard business tariff that customers would otherwise pay, and

b) applying additional escalation factors to these increases to limit charges for transitional and obsolete tariffs falling further below cost in dollar terms.

This approach carried forward in the 2014-15 determination. In the draft determination for 2015-16, QCA wrote, "… we considered that a 10% increase was not unreasonable". But it proposed a 5% increase as being more appropriate in light of the price increases customers had faced in recent years. In the final determination for 2015-16, tariffs for transitional and obsolete tariffs were unchanged despite there being a reduction in standard business tariffs.

The effect of the QCA decisions made in 2013-14 and each subsequent determination is to narrow the notional gap QCA saw between transitional and obsolete tariffs and tariffs based on N+R pricing framework, so-called cost reflective tariffs.

In making these decisions, QCA has provided no evidence to support the notion that the transitional and obsolete irrigation tariffs (T62, T65 and T66) do not in fact cover the costs of supplying electricity to the state's irrigators. In January 2015[1], QCA was asked to provide "any information as to how un-cost reflective the transitional tariffs of 62, 65 and 66, and to what extent the gap as closed over the past three determinations". QCA responded, "We don't have data showing how far away each transitional tariff is from cost".

That the historic irrigation tariffs are not based on the N+R pricing framework demonstrates a flaw in the network pricing framework. It does not mean the tariffs are not cost reflective.

With Irrigation tariffs almost doubling (they increased 96% compounded) over the seven years to 2014-15, Ergon's revenue take from these tariffs is likely to have increased sharply over the same period[2]. This is a significant increase considering Ergon's network investment decisions have been driven by the needs of its urban and industrial users, not by the needs of irrigated agriculture.

CANEGROWERS calls on QCA to discontinue the practice of accelerating price increases for irrigation tariffs above other price increases. There is no valid justification for its continuation.

Energy Costs

Despite global energy prices being at their lowest level for many years, Queensland has the highest wholesale power prices in the National Electricity Market and this is despite the state having access to world-competitive coal supplies and there being significant surplus electricity generating capacity in Queensland. In its state of the market report for 2015, the AER identified the "opportunistic" behaviour of the Queensland government's state-owned generators as making a significant contribution to this perverse wholesale price outcome. This opportunistic pricing behaviour is illustrated in AEMO market data from January 2015 (chart). Queensland had a huge surplus of available power generating capacity that that was comfortably, close to 25 per cent, above demand during those price spikes.

The AER noted Queensland was the only region recording an increase in wholesale energy prices, a perverse outcome given the fact that Queensland generators on average have a lower cost structure than NSW generators.

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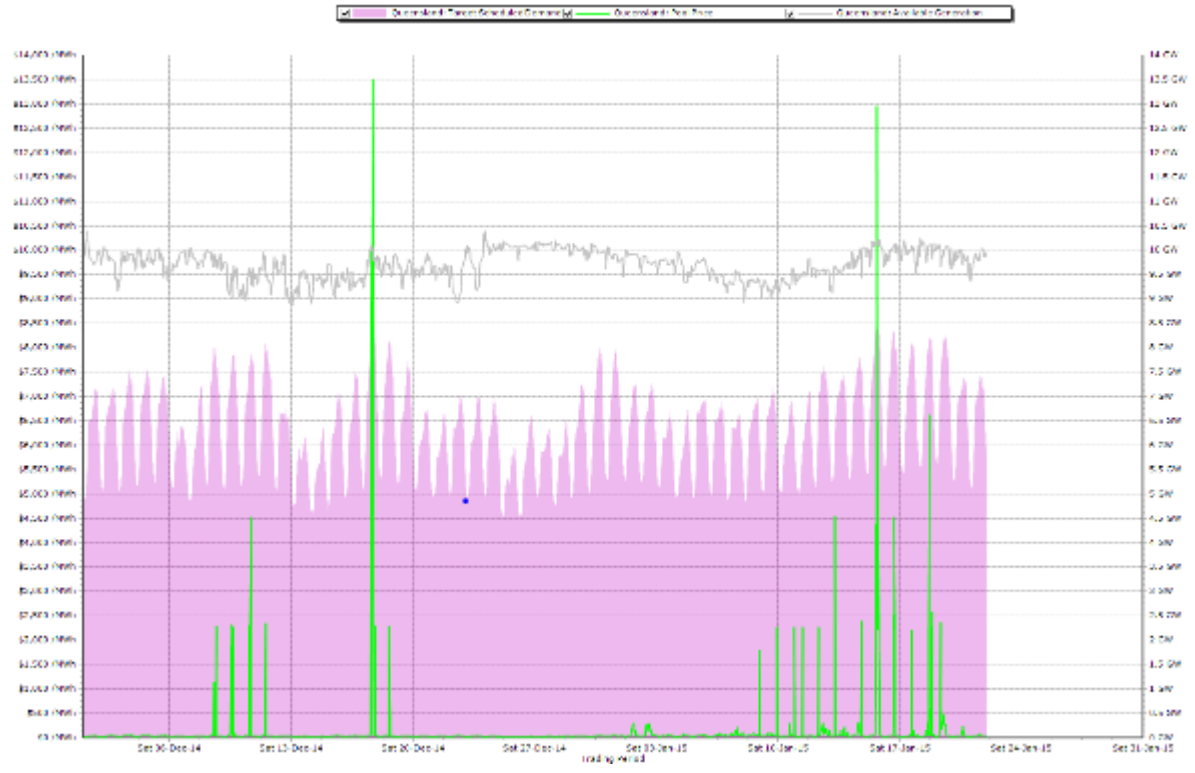
[1] Cotton Australia (February 2015), Submission to QCA Regulated Retail Electricity Price Determination 2015-16.

[2] CANEGROWERS is working closely with Ergon and the Department of Energy and Water Supply to understand the relationship links between electricity consumption for irrigation use, prices and Ergon's revenue collections from electricity supplied under the irrigation tariffs (T62+T65+T66) as part of a project examining the merits of a proactive electricity policy to combat El Niño. Pending their review of the data, Ergon has asked that CANEGROWERS not share the preliminary data collected for this project with QCA.

It's important that the impact of this wholesale energy price manipulation is not passed on to consumers in the 2016-17 price determination.

CANEGROWERS calls on QCA to acknowledge the anti-competitive price gaming behaviour of Queensland's generator and discount the price increases that would otherwise be passed through to consumers.

Trended Trading (half hourly) Data for Queensland for the period December 2014 to 21 January 2015



Source: NEM Review using AEMO market data

Remove Headroom

QCA continues to allow a margin for retail headroom in notified prices to "reward investors for a retailer's exposure to systematic risks associated with providing customer retail services". The allowance is designed to facilitate retail competition in Energex's South-East Queensland (SEQ) network. QCA's price comparator tool shows that retailers have consistently offered prices below QCA's notified prices. Albeit delayed, the change to price monitoring in SEQ is likely to trigger further changes to prices and innovation in the value propositions that retailers offer customers connected the Energex network. It is likely that "standing offer prices" in SEQ will be below existing price levels and well below the prices foreshadowed in QCA's draft determination.

The AER reports that the gap between the average contract price and the average standing price in Queensland is just 1.9 per cent — compared to up to 18 per cent in Victoria and 12.1 per cent in New South Wales.

These competitive retail price offerings have not been and are not available to Ergon's retail customers. Without the opportunity to access prices lower than QCA notified prices, Ergon's retail customers continue to be at a price disadvantage to their SEQ counterparts.

The Ministerial Direction requires QCA to develop uniform tariffs for 2016-17. This direction can only be implemented if QCA removes the headroom allowance for the retail prices it determines for Ergon's retail customers. Without this change, Ergon's retail customers will

continue to be disadvantaged by facing prices higher (1.9 per cent higher on the AER's state of the market 2015 estimate) than those available to consumers in the more competitive SEQ electricity market.

CANEGROWERS calls on QCA to:

- ***remove the headroom allowance from the regulated retail prices it determines for Ergon's customers, and***
- ***recommend to government that it target its CSO payment to Ergon's network business to enable the development of retail price competition in regional Queensland.***

Solar bonus scheme

Electricity consumers across Queensland continue to be disadvantaged and the international competitiveness of Queensland's traded goods sector impaired by the continuing requirement of financing the solar feed-in tariff (SFIT) scheme from network revenues.

CANEGROWERS calls on the QCA to recommend to the state government that the SFIT scheme is funded from general revenues.

Conclusion

Enabling the sugar and other agricultural industries across the state to build on their underlying strengths and invest and expand their activities within a stable business enabling policy framework is the best way to drive the economic growth and development of rural and regional Queensland. This can only be achieved if the regulated retail electricity prices QCA determines are at levels that reflect prudent and efficient cost structures.

Currently above this level, electricity prices in Queensland are encouraging consumers to seek alternative energy sources and accelerating the onset of disruptive alternative energy solutions. This risks existing assets being stranded and the prospect of electricity users across the state facing ever higher electricity prices.

Yours faithfully

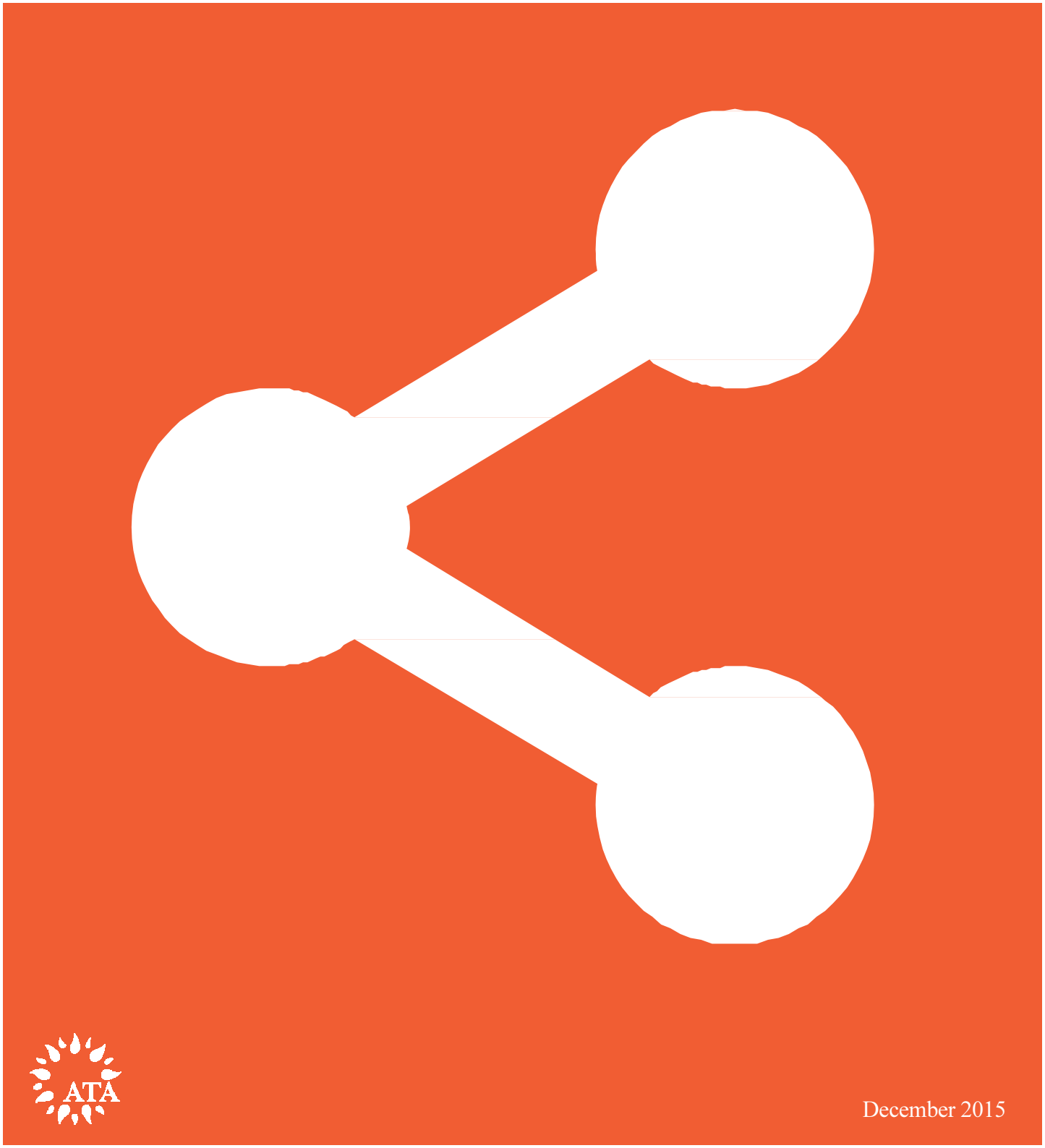
Dan Galligan
Chief Executive

Attachments

1. Tariff Design Options, Alternative Technology Association (December 2015)

Tariff design options

Report for CANEGROWERS



ATA

December 2015

1.0 Document Information

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Canegrowers v1.0	18/12/15	Kate Leslie	Craig Memery	
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Prepared for CANEGROWERS

Disclaimer

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The views expressed in this document do not necessarily reflect the views of Energy Consumers Australia.

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Contents

2.0 Introduction

The objectives of this report are to

- Assist in quantifying the impacts and opportunities that Ergon Energy's proposed new tariffs present for Queensland's irrigators
- Identify which 'cost reflective' tariff options are better reflect the needs of irrigators served by the Ergon Energy electricity network and allow them opportunity to reduce costs
- Assist CANEGROWERS in engaging with Ergon Energy and the AER in relation to Ergon Energy's TSS approval process.

CANEGROWERS has raised the following concerns regarding new tariffs proposed by Ergon Energy

- Ergon Energy's proposed 10am - 8pm summer kW peak window is too wide to enable many irrigators to respond effectively without comprising crop yields
- Ergon Energy's different approaches to summer peak calculation (top 4 energy days) and off-peak (Max ½ hourly kW demand) is confusing and limits consumers' ability to implement measures that respond effectively to tariffs in the summer period
- Location-specific voluntary tariffs that appropriately incentivise different types of irrigators to reduce demand at peak times are required.

To quantify these matters, ATA has analysed

- Tariffs proposed by Ergon Energy in their proposed tariff structure statement
- Alternative tariff designs considered by CANEGROWERS and ATA to be
    - appropriate in the context of the new distribution pricing rules
    - suited to Ergon Energy's network
    - potentially better suited to meet the needs of irrigators, in particular canegrowers.

ATA's approach to this analysis is detailed further within this report.

2.1 Key findings

The analysis

- strongly supports the view that cane growers will be better off with optional location-specific 'cost reflective' pricing options that are targeted at particular irrigation types
- suggests that Ergon Energy's proposed 'top 4 energy days' is actually preferable for some irrigators than a conventional peak demand charge (Max ½ hourly kW demand).

If Ergon Energy's proposed 10 hour summer peak period was shortened (to 5 hours for example), opportunities for load shifting for canegrowers are materially improved for many 'winch' and 'pivot' irrigators. Indeed, most may be able to avoid peak periods altogether if they are short enough.

Tariffs with demand charges tend to impact irrigators adversely if they cannot shift load, as is the case for many furrow irrigators.

Critical Peak Pricing and Peak Time Rebates are effective tools to enable all cane growers, including furrow irrigators, to share the benefit of reducing peak load on the network.

Ergon Energy's proposed 'anytime' peak charge for non-summer months provides irrigators with no incentive to load shift or to reduce that charge in any other practical way. It would be preferable for irrigators if the summer demand structure was consistent across the full year, at least with respect to the peak periods.

The way Ergon Energy's proposed SAC peak summer charge is calculated affects whether cane growers are better off with a longer (10 hour) or shorter (5 hour) peak window. Irrigators that have an ability to load shift are generally better off with a shorter peak period, whereas most others are worse off, particularly if they can't shift load and their average load is higher during the shorter window than the longer window.

3.0 Background

3.1 Ergon Energy's Proposed Demand Tariffs

In March 2015 Ergon Energy published a consultation paper[1]. New optional demand tariffs were proposed within that paper. [2]

In November 2015, Ergon Energy submitted to the Australian Energy Regulator a Tariff Structure Statement[3]. The key features of the tariff structure[4] and the proposed numbers[5] appeared to be unchanged from the March 2015 consultation paper.

Ergon Energy's tariffs differentiate between small or large users. Key features of the optional seasonal time of use tariffs for large users (>100MWh), 'Seasonal TOU Demand East' (ESTOUDC), are-

Fixed Charge	$32	Dollars per day
Consumption charge non-summer	$0.03364	Dollars per kWh
Consumption charge summer	$0.00	Dollars per kWh
Demand threshold Summer	20	kW
Demand threshold Non-Summer	40	kW

[1] Ergon Energy, Consultation Paper Our Network Tariff Reform Report *Network Tariff Reforms 2015-16 * Tariff Structure Statement, 2016-20, June 2015. https://www.ergon.com.au/__data/assets/pdf_file/0016/270610/Consultation-Paper-Network-Tariff-Reform-AMENDED.pdf

[2] See pages 34 & 35 for Small Asset Customers Large users, and pages 38 & 39 for Small Asset Customers Small customers.

[3] https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/pricing-proposals-tariffs/ergon-energy-tariff-structure-statement-2015/proposal

[4] Ergon Energy, Tariff Structure Statement 2017-18 to 2019-20, 27th November 2015, page 22 for Small Asset Customers (using <100MWh) and page 26 for Large customers (>100MWh).

[5] For LRMC see p29 of Appendices. For Small Asset Customers see p48 Seasonal Time of Use Demand Business East (EBTOUD). For Small Asset Customers Large see p51 Seasonal Time of Use Demand East (ESTOUDC).

Key features of the optional seasonal time of use tariffs for small business users (<100MWh), 'Seasonal TOU Demand Business East' (EBTOUD), are-

Fixed charge	$0	Dollars per day
Consumption charge	$0.02835	Dollars per kWh
Summer Peak Period: Start of period	10:00	
Summer Peak Period: End of period	20:00	
Summer Peak Period: Include weekends?	No	
Summer peak charge[6]	$80.554	Dollars per kW
Non-Summer peak charge	$12.000	Dollars per kW
Non-summer min. Dmd	3.00	kW

3.2 Matters investigated and ATA's approach

3.2.1 Peak periods

CANEGROWERS has raised concern that Ergon Energy's proposed 10am to 8pm summer kW peak window is too wide to enable many irrigators to respond effectively without comprising their crop yields, thereby limiting the effectiveness of the price signal and the ability to implement regular timer-based operations[7].

CANEGROWERS asked Ergon Energy to consider reducing the 10am to 8pm summer peak window, and consider location-specific pricing to send a more cost reflective signal that consumers can respond to effectively.

ATA has analysed the price impacts of reducing the length of the peak window period.

In ATA's view, a four-hour peak window is adequate to capture the actual system peaks at a given location, therefore this analysis uses a five-hour peak, which can be considered broadly representative of a four to six-hour window in terms of price and irrigation impacts.

[6] "The monthly demand charges, for both summer and non-summer, are based on the average demand the customer places on the network in the daily demand window. For business customers, the demand window is the half hours between 10.00 am and 8.00 pm on Weekdays... We look at the highest four demand days in the month, determined by the average demand recorded in these daily demand windows. We apply the monthly demand rate to the average of these top four demand days." Ergon Energy, Tariff Structure Statement 2017-18 to 2019-20, November 2015, p22.

[7] Further, ATA notes that charging consumers in all parts of the system similarly (irrespective of when the system serving them peaks) over a 10 hour period, may result in them shifting some loads within that period in a manner that moves some loads towards the actual peak. This would clearly be a perverse outcome.

As location-specific charges might be required to justify shorter peak periods, ATA analysed low, medium and high off peak kW charges, reflective of a plausible range of LRMC values in different locations, whereby

- Low $/kW charge = an unconstrained location with low LRMC
- Medium $/kW charge = equivalent to system wide average charge proposed by Ergon Energy
- High $/kW charge = a location with emerging constraints and therefore high LRMC

3.2.2 Peak charging approach

CANEGROWERS raised concern that Ergon Energy's different approaches to summer peak calculation (top 4 energy days) and off-peak (Max ½ hourly kW demand) is confusing and limits the ability of consumers to implement measures that respond effectively to tariffs in the summer period.

ATA's analysis compares the effectiveness of the two options for charging for peak demand in terms of consumer impact, for the 10 hour peak window proposed by Ergon Energy and the alternate 5 hour peak window outlined above.

3.2.3 Critical Peak Pricing and Peak Time Rebates

CANEGROWERS requested that Ergon Energy also introduce voluntary tariffs that appropriately incentivise different types of irrigators to reduce demand at peak times. It is clear that a one size tariff does not fit all irrigation types[8].

For cane growers that use furrow irrigation, interrupting their operations daily would cause unacceptable impact. However they are still able to interrupt their loads from time to time. A tariff that incentivises up to 10 load-switching events per summer with a very high price on the highest demand days (commonly known as a Critical Peak Price (CPP)) can address peak demand in constrained networks, and most irrigators could respond by reducing or eliminating loads on those days.

A Peak Time Rebate (PTR) is similar to a CPP in terms of timing and triggers, but rather than including a higher tariff the network business makes a payment to the irrigator if they reduce their load on those days.

ATA analysed the impacts of CPP and PTRs for cane growers.

[8] *"Irrigators don't require power every day ... What further complicates things is that water requirements vary from 15mm/week to 60mm/week depending on the season and crop age. Irrigation systems are designed to meet the 50mm or 60mm/wk demand which is required in summer. In the non summer months there is potential for pivot and winch to avoid peak hours but in summer without any relief from rain they too operate 24/7. Irrigators make 100% use of off peak and weekend hours but often this is insufficient time to complete the task." Rajinder Singh, Director Canegrowers Tablelands, email 5th November 2015*

3.3 Load Profiles

This analysis is based on

- Interval data sourced from metered irrigation sites and supplied by Ergon Energy
- Synthesised interval data developed by using other information to represent the load profiles of canegrowers in the Bundaberg and Tablelands regions.

Ergon Energy provided a number of meter data files representing different load profiles.

Most of the files provided were of less than 6 months duration, so not representative of the whole year.

The files with 12 months worth of data are –

Table 3-1: Useful Load Profile Files

NMI	IrrigScale	IrrigType	Region
3033626847	<100MW	Furrow	Burdekin
3041667174	<100MW	Furrow	Bundaberg
3041667905	<100MW	Furrow	Bundaberg
3042007054	<100MW	Winch	Bundaberg
3052073629	<100MW	Furrow	Burdekin
QEEE7000713	>100MW	Pivots and furrow	Tableland
30309955583	<100MW	Pivot	Tableland
30310108738	>100MW	Pivots and furrow	Tableland

Of the 8 usable (>12 months) load profiles, four are furrows, two are pivots and furrow and there is one each of pivot and winch. Two irrigators use more than 100MWh annually.

The key variables that needed to be represented in the load profiles were

- type of irrigation
  - furrow
  - winch or
  - pivot
- Region
  - Bundaberg or
  - Tablelands

CANEGROWERS and ATA were concerned that the sample of winch and pivot loads was not representative, however sufficient meter data to address this issue was not available. Dr Martin Gill was engaged to simulate more 'pivot and winch' load profiles using various source. Dr Gill generated 7 load profiles for a year with average rainfall as follows:

Table 3-2: Additional Load Profiles Generated

File name	Region	Irrigation Type	Dr Gill Comment
Simulated Scenario 40KW	Bundaberg	Winch	Simulation using rain deficit approach for a pump size of 40kW
Simulated Scenario 25KW	Bundaberg	Winch	Simulation using rain deficit approach for a smaller crop and pump size of 25kW
Winch Bundaberg 40KW	Bundaberg	Winch	Scaled NMI 3042007054 to a pump size of 40kW (false peaks removed)
Winch Bundaberg 11KW	Bundaberg	Winch	Scaled NMI 3042007054 to a pump size of 11kW (false peaks removed)
Winch Bundaberg 25KW	Bundaberg	Winch	Scaled NMI 3042007054 to a pump size of 25kW (false peaks removed)
Pivot Tablelands 25kW	Tablelands	Pivot	Provided pump start and stop times for a pump size 25kW
Pivot Tablelands 55kW	Tablelands	Pivot	Provided pump start and stop times for a pump size 55kW

3.4 Tariffs Model

ATA developed a model for calculating Ergon Energy's optional Seasonal Time of Use Demand tariffs from load profiles based on half hour time intervals. The model also has load shifting analysis capability.

The model calculates tariffs for four combinations of assumptions based on the load profile: Large 1, Large 2 (a variation of Large 1), WA1 and WA2 (a variation of WA1). The model has many variables including:

- the values of inputs
- which months to consider as Summer
- whether peak tariffs apply to weekends; and
- which timeframes to include in peak windows.

Large 1 and WA1 assumptions are consistent with the Ergon Energy's Tariff Structure Statement for Large and Small Standard Asset Customers respectively. The table below outlines the standard assumptions/inputs for the four output tariffs:

Tariff Components		Standard Asset Customers		
Descriptor	**ATA Terminology**	Large	Small	**Unit**
		>100MWh	<100MWh	
Fixed Charge	Large1	$32	$0	Dollars per day
Consumption charge non-summer	Large1	$0.03364	$0.02835	Dollars per kWh
Consumption charge summer	Large1	$0.00	$0.00	Dollars per kWh
Demand threshold Summer	Large1	20	0	kW
Demand threshold Non-Summer	Large1	40	0	kW
Demand charge Summer	Large1**	$ 47.829	$ 80.554	Dollars per kWh, max per month
Demand charge Non-summer	Large1	$ 12.936	$ 12.000	Dollars per kWh, max per month
Fixed Charge	Large2	$32	$0	Dollars per day
Consumption charge non-summer	Large2	$0.03364	$0.02835	Dollars per kWh
Consumption charge summer	Large2	$0.00	$0.00	Dollars per kWh
Demand threshold Summer	Large2	20	0	kW
Demand threshold Non-Summer	Large2	40	0	kW
Demand charge Summer	Large2**	$ 47.829	$ 90.000	Dollars per kWh, max per month
Demand charge Non-summer	Large2	$ 12.936	$ 12.000	Dollars per kWh, max per month
Fixed charge	WA1		$0	Dollars per day
Consumption charge	WA1		$0.02835	Dollars per kWh
Summer Peak Period: Start of period	WA1		10:30	End of time interval
Summer Peak Period: End of period	WA1		20:00	End of time interval

Summer Peak Period: Include weekends?	WA1	No	
Summer peak charge (aka Optional Locational Charge)	WA1	$ 80.554	Dollars per kW
Non-Summer peak charge	WA1	$ 12.000	Dollars per kW
Non-summer min. Dmd	WA1	3.00	kW
Fixed charge	WA2	$0	Dollars per day
Consumption charge	WA2	$0.02835	Dollars per kWh
Summer Peak Period: Start of period	WA2	11:30	End of time interval
Summer Peak Period: End of period	WA2	16:00	End of time interval
Summer Peak Period: Include weekends?	WA2	No	
Summer peak charge (aka Optional Locational Charge)* **	WA2	$ 90.000	Dollars per kW
Non-Summer peak charge	WA2	$ 12.000	Dollars per kW
Non-summer min. Dmd	WA2	3.00	kW

3.5 Analysis

ATA developed a model for calculating Ergon Energy's optional Seasonal Time of Use Demand tariffs from load profiles based on half hour time intervals. The model also has load shifting analysis capability.

Ergon Energy proposes a peak window of 10am-8pm for business customers (10 hours). ATA modelled tariffs for an alternative 5 hour peak window. A window of 11am-4pm was chosen after observing the pattern of use among the non-furrow irrigators, and to represent times with some full pumping load (to avoid underestimating the benefit of load shifting) and some low load (to avoid overestimating the benefit of load shifting), while assuming a plausible local system peak time.

A tariff that incentivises up to 10 load-switching events per summer with a very high price on the highest demand days (commonly known as a Critical Peak Price or CPP) can address peak demand in constrained networks, and most irrigators could respond by reducing or eliminating loads on those days.

A Peak Time Rebate (PTR) is similar to a CPP in terms of timing and triggers, but rather than including a higher tariff the network business makes a payment to the irrigator if they reduce their load on those days.

There are two main variables for sensitivity testing:

- different Long Run Marginal Costs (LRMCs); and
- the times of the peak window.

Sensitivity tests were conducted on a number of variables reflecting different long run marginal costs (LRMC) with three optional location charges - low @ $20/kW/month, average @$90/kW/month or High @$200/kW/month.

The variable used in ATA's model (the mechanism) for the calculation was WA2 summer peak charge. The high charge of $200/kW is consistent with approximately $500/kVA LRMC.

3.6 Loadshifting rationale and logic

A Bundaberg Regional Irrigators Group options briefing paper[9] prepared by Dale Hollis summarised that furrow irrigation has high labour input so is "best operated in daylight or early evening hours" (p2) whereas for winch irrigation "wind impacts highly on efficiency, [so is] best operated in overnight hours [when winds are lower, to minimise evaporation losses]" (p3).

For cane growers that use furrow irrigation, interrupting their operations daily would cause unacceptable impact, however they are able to interrupt their loads from time to time. By contrast, 'pivot and winch' irrigators have more options to shift load, and may be able to respond to peak windows that either occur every day, all year, every day during Summer months, or during critical periods.

Loads are only shifted from peak charging periods to other periods. CANEGROWERS nominated 72 intervals (36 hours) as a maximum period for deferring shifted load before the impacts on crop yield were unacceptable. ATA's model therefore treats that as an absolute limit: the load shifting macro within the model identifies load in peak periods and defers those load to the next non-peak interval that has no load, unless doing so would move that load more than 36 hours from its original interval. This approach allows an assessment of load shifting potential within the limits of crop requirements.

[9] Undated document supplied by Dale Hollis to Craig Memery on 22 September 2015 14:36.

4.0 Results

4.1 Furrow Irrigators

Given the load profiles, the components of electricity bills for furrow irrigators with Ergon Energy's proposed peak window of 10am-8pm are outlined below:

Scale	<100MW
IrrigationType	Furrow
OptionalLocationTariff	90
Loadshifting	None

	NMI			
Values	**3033626847**	**3052073629**	**3041667905**	**3041667174**
WA1_FixedCost	$0	$0	$0	$0
WA1_ConsumptionCost	$2,585	$220	$600	$713
WA1_DemandCostSummer	$8,113	$1,337	$1,504	$5,140
WA1_DemandCostNonSummer	$2,308	$365	$1,845	$1,666
WA1Total	$13,005	$1,922	$3,948	$7,518

A shorter 5 hour peak window provides no benefit for furrow irrigators. Here would be the components of electricity bills with a Summer peak window of 11am-4pm.

Scale	<100MW
IrrigationType	Furrow
OptionalLocationTariff	90
Loadshifting	None

	NMI			
Values	**3033626847**	**3052073629**	**3041667905**	**3041667174**
Average of WA2_FixedCost	$0	$0	$0	$0
Average of WA2_EnergyCost	$2,585	$220	$600	$713
Average of WA2_DemandCostSummer	$8,972	$1,455	$2,481	$7,195
Average of WA2_DemandCostNonSummer	$2,308	$365	$1,845	$1,666
Average of WA2Total	$13,865	$2,040	$4,925	$9,573

4.2 Load-shifting

The statistics on load-shifting present the number of periods and kWh shifted for Ergon Energy's proposed 10 hour window and for the shorter 5 hour window. Please refer to Section 3.6 for more information about load-shifting rationale and logic.

	NMI			
	Loadshifting 10am-8pm		Loadshifting 11am-4pm	
	No.intervals	kWh	No.intervals	kWh
<100MW	**551**	**3835**	**224**	**1436**
Winch				
3042007054	556	5687	220	2172
RainDeficitSim B'berg 25kW	978	5748	390	2083
RainDeficitSim B'berg 40kW	832	7886	300	2638
Bundaberg 11kW	542	1461	220	573
Bundaberg 40KW	542	5320	220	2085
Bundaberg 25KW	542	3323	220	1303
Pivot				
30309955583	216	21	122	12
Tablelands25kW	202	1233	102	621
>100MW	**200**	**1936**	**117**	**1122**
Pivot				
Tablelands55kW	202	2731	102	1377
Pivots and Furrow				
QEEE7000713	342	3017	216	1956
30310108738	56	60	32	34

4.3 Optional Locational Charge

The total annual electricity bills for small SAC customers assuming the peak window as proposed by Ergon Energy (10am-8pm) are outlined below. The Summer peak charge (WA1) is $80.554/kW/month. Loadshifting in Summer could reduce the bills for winch and pivot irrigators. Winch operators particularly benefit, with savings of around 60%.

Scale	<100MW

Average of WA1Total	NMI		Difference	
Row Labels	None	Loadshifting 10am-8pm	$	%
Winch				
3042007054	$11,025	$4,324	-$6,700	-61%
RainDeficitSim Bundaberg 25kW	$5,478	$2,432	-$3,046	-56%
RainDeficitSim Bundaberg 40kW	$8,640	$3,642	-$4,998	-58%
Bundaberg 11kW	$3,014	$1,212	-$1,802	-60%
Bundaberg 25KW	$6,669	$2,650	-$4,018	-60%
Bundaberg 40KW	$10,590	$4,157	-$6,433	-61%
Pivot				
30309955583	$392	$361	-$31	-8%
Tablelands25kW	$9,451	$8,945	-$506	-5%

Alternatively with a shorter time window 11am-4pm (and with a consequentially increase to the demand charge to $90), the total annual electricity bills for variable LRMCs (a Summer peak charge of $20, $90 or $200/kW/month) are outlined below:

Scale	<100MW

Average of WA2Total	NMI					
	None			Loadshifting 11am-4pm		
Row Labels	20	90	200	20	90	200
Winch						
3042007054	$5,202	$11,510	$21,423	$3,519	$3,941	$4,603
RainDeficitSim B'berg 25kW	$3,305	$6,351	$11,138	$2,432	$2,432	$2,432
RainDeficitSim B'berg 40kW	$5,029	$9,878	$17,499	$3,642	$3,642	$3,642
Bundaberg 11kW	$1,478	$3,142	$5,757	$1,022	$1,133	$1,308
Bundaberg 25KW	$3,177	$6,960	$12,904	$2,168	$2,420	$2,818
Bundaberg 40KW	$5,000	$11,056	$20,573	$3,384	$3,789	$4,425
Pivot						
30309955583	$358	$404	$475	$349	$365	$390
Tablelands25kW	$4,947	$10,153	$18,333	$4,822	$9,588	$17,079

5.0 Critical Peak Pricing and Peak Time Rebates

Critical peak periods are typically several hours long on a given day, and occur up to 10 times per year, possibly during heat waves. Customers would be informed of a Critical Peak Pricing (CPP) event at least a day in advance. With critical peak pricing, those consumers who can reduce their energy use on those days, or already have lower energy use, will save money, whereas others won't.

With CPP pricing it is assumed that cane growers would choose not to irrigate their crops on any critical peak days, hence avoiding CPP charges altogether. This would have the same effect on bills as removing any peak charges. The benefits of this are calculated accordingly.

The value of the Peak Time Rebate (PTR) is estimated to be only 50% of 'demand' value attributed to a CPP, owing to the risks under a PTR being shared between consumers and the network.

With CPP, the composition of annual electricity bills for SAC Small customers are set out in the first three columns, with the total bill in column "Average of CPP_WA1". The charge under a PTR is set out in the last column.

Scale	<100MW				Charge Avoided	
	Values					
Row Labels	Average of WA1_Fixed Cost	Average of WA1_Energy Cost	Average of WA1_Demand CostNon-Summer	Average of CPP_WA1	Average of WA1_Demand CostSummer	Peak Time Rebate
Winch						
3042007054	$0	$1,758	$1,640	$3,399	$4,489	$2,245
RainDeficitSim B'berg 25kW	$0	$1,390	$1,042	$2,433	$1,897	$948
RainDeficitSim B'berg 40kW	$0	$2,042	$1,600	$3,642	$3,084	$1,542
Bundaberg 11kW	$0	$448	$539	$987	$1,181	$590
Bundaberg 25KW	$0	$1,054	$1,041	$2,095	$2,692	$1,346
Bundaberg 40KW	$0	$1,688	$1,581	$3,269	$4,310	$2,155
Pivot						
30309955583	$0	$21	$324	$345	$31	$15
Tablelands25kW	$0	$2,227	$1,232	$3,460	$5,732	$2,866

For SAC Large users, annual electricity bills would be –

Scale	>100MW				Charge Avoided	
	Values					
Row Labels	Average of Lg1_FixedCost	Average of Lg1_EnergyCost	Average of Lg1_DemandCostNonSummer	Average of CPP_Lg1	Average of Lg1_DemandCostSummer	Peak Time Rebate
Pivot						
Tablelands55kW	$11,680	$3,532	$0	$15,212	$1,054	$527
Pivots and Furrow						
QEEE7000713	$11,680	$3,861	$79	$15,620	$596	$298
30310108738	$11,680	$11,136	$2,766	$25,582	$2,800	$1,400

6.0 Discussion

6.1 Consumer classification and tariffs

In ATA's view, there is a clear case for there to be a range of network tariffs available that reflects the nature of irrigators having a higher-than-average load factor compared to other consumers, and being

- interruptible at times of critical peak in the case of furrow irrigation, and
- able to be operated in the off-peak in the case of winch and low pressure overhead irrigation.

In this respect, for the purpose of tariff design in the context of the current network tariff rules, it would appear appropriate that irrigators are treated as a separate class of energy consumer in regions where they constitute a significant portion of the overall consumer base. For example:

- Tariffs for furrow irrigators could include critical peak pricing to provide an incentive for those irrigators to switch off loads during critical peak summer days, as determined by Ergon, on which demand peaks or network constraints may occur.
- Other irrigation tariffs would have peak and off-peak rates, with
    - A daily (or weekday) peak period of no more than 4 or 5 hours for any location. ATA's analysis considered an 11am to 4pm peak window, which would suit some locations but not others. For example, a 3pm to 8pm period may be more appropriate in locations where residential use has more effect on peak demand, and
    - off peak periods
        - being all other times,
        - having low enough charges to incentivise more energy use, and
        - not being subject to 'any-time' peak demand charges (such as the off-peak demand charge proposed by Ergon).

6.2 Long Run Marginal Costs (LRMC)

There is a lack of reliable and granular information of the incidence of costs across Ergon's network. Ergon Energy also do not differentiate between customer types and voltage connection levels. In ATA's view, this approach should be questioned. Our discussion with Ergon Energy about their process of converting LRMC to a summer tariff is included in Appendix A below.

6.3 Assessment of consumer impacts

ATA appreciates the effort Ergon Energy's efforts in providing us with some meter data to assist this assessment of the impacts of different tariff options. Given the lack of capture and retention of existing interval meter data, we question however whether Ergon can, or do, adequately analyse the impact of proposed network tariffs on different classes of customers.

6.4 Load shifting

Based on the tariffs proposed by Ergon, load shifting has different effects according to whether the irrigator's energy use is <100MWh or >100MWh.

For SAC Small customers

- Load shifting only makes sense in summer months. There is no financial benefit to load shifting at other times, as non-summer demand charges occur at anytime (compared to summer demand charges). This appears to reflect the lack of network constraints outside of summer months. While lower capacity pumps or VSDs would reduce the non-summer peak demand, the charge itself is so low that any upfront cost appears unlikely to pay for itself.
- Some small SAC customers may be able to shift the whole of their loads out of the peak window, bringing the Summer peak demand charge down to zero. An example is the Simulated 25kW Bundaberg winch. This irrigator has Summer peak loads of 12-18kWh which are able to be shifted to another period.

Large SAC customers – None of the load profiles analysed resulted in decreased bills as a result of load shifting. Load shifting would only be useful if it impacts maximum monthly demand charge. Two examples included:

- Pivot and Furrow SAC Large NMI 30310108738, 60kWh shifted (with period 10am-8pm) but didn't impact bills because it didn't change maximum monthly demand.
- The simulated Tablelands pivot 55kW shifted 2,731 kWh, with no effect on bills as the maximum monthly demand during the peak window was unchanged.

7.0 Appendix A – Relationship Between LRMC and Demand Charges

From: CROWN Brendon (Ergon) [mailto:brendon.crown@ergon.com.au]
Sent: Thursday, 8 October 2015 11:05 PM
To: Craig Memery
Cc: 'Warren Males'; Kate Leslie; COLLINS Sara (FN)
Subject: RE: Questions for Ergon - relationship between LRMC and demand charges

Hi Craig
My apologies for not getting back to you earlier. I have been out of the office this week.
There is a reasonably complex but necessary process in converting the LRMC calculation to a customer's tariff. I will try and provide more context and references when I am back in the office. Hopefully the below explanation can suffice for now.
Our LRMC value by voltage type is calculated on a $ per KVA per annum. We have not applied the full LRMC value to our peak charge in all circumstances. The LRMC value we calculated was based on the capital expenditure, growth and WACC assumptions in our October 2014 regulatory proposal. We will need to review LRMC calculations (presumably downward) with the outcome at the end of this month. We also need to balance cost reflectivity with customer impact, particularly as our LRMC based tariffs are "opt in" for customers.
We apply this LRMC (peak charge) value to the peak time period. To do this we need to allocate the $/KVA/year value to the months (summer) and periods in which LRMC will be allocated. We also take into account the level of diversity or the likelihood that the customers demand will coincide with the network peak. All this is done to ensure we don't over-recover the LRMC through the peak charge.
In summary, the peak charge is the application of the LRMC value to the periods most likely to contribute to incremental investment in the network. The off-peak demand charge does not recover LRMC. We use a combination of off-peak demand, fixed and energy charges to recovery the non-LRMC or residual costs
I will try and get to the specifics of the numbers when I get back to the office. From memory, one of the tables in the consultation paper represented the regulated retail tariff (which would incorporate both retail and network elements) which caused concern for another stakeholder.
Thanks again for your ongoing interest.

Brendon Crown
P 07 3851 6785 **F** 3851 6780 **M** 0400 384 894
ergon.com.au

From: Craig Memery [mailto:craig.memery@ata.org.au]
Sent: Monday, 5 October 2015 4:25 PM
To: CROWN Brendon (Ergon)
Cc: 'Warren Males'; Kate Leslie; COLLINS Sara (FN)
Subject: FW: Questions for Ergon - relationship between LRMC and demand charges

Hi Brendan, hope you are well
We are working with CANEGROWERS to understand the impacts of proposed tariffs and understand different tariff options for food and fibre producers.
We have the following questions about Ergon's approach to LRMC:
How has the peak Summer charge been calculated?
How has the non Summer peak charge been calculated?
How was LRMC calculated?

What is the relationship between the LRMC and the Summer peak charge?
The purpose of these questions is to help us to apply credible charges to revised structures that we are testing for our own analysis.
Please copy Kate (cc'd) into these communications.
Cheers,
Craig

From: Kate Leslie
Sent: Monday, 5 October 2015 4:39 PM
To: Craig Memery
Subject: Questions for Ergon - relationship between LRMC and demand charges

Hi Craig,
On p17 of Ergon's June Consultation paper, the only reference to "application of LRMC to tariffs" is this -

> *For SAC <100 MWh p.a. – application to the average of the customer's demand recorded during peak times for the highest four peak demand days in the month in the SToUD tariff and equalisation of the peak and shoulder energy rates in the Season ToU Energy (SToUE) tariff*

As they say on page 18 -

> *"We have been consulting with customers on our approach to calculating the LRMC. We released the following papers this year:*
> - *Aligning Network Charges to the Cost of Peak Demand*
> - *Long Run Marginal Cost Considerations in Developing Network Tariffs*
> - *Estimating the Average Incremental Cost of Ergon Energy's Distribution Network*
> - *The Case for Demand Based Tariffs.[6]"*

I've had a quick peek at the first two documents, but I haven't seen anything that helps us understand how they get from LRMC of $189 per kW per annum (e.g SAC < 100 MWh p.a. Business, East) to proposed Summer peak charge of $80.554 per kW per month for a customer's Top 4 days. So I've got questions for Ergon around "How's the peak Summer charge been calculated? How's the non Summer peak charge been calculated? What is the relationship between the LRMC and the Summer peak charge? How was that calculated?"
Thanks,
Kate

8.0 Appendix B – Dr Martin Gill's Interval Data Files

Introduction

While many of the electricity meters installed on the irrigation pumps are programmed to store interval data, Ergon does not collect the interval data. The only interval data made available for this analysis was provided by a special meter read. The number of days of data is therefore limited to the limited storage internal to the meter.

Compounding the problem was that many of the meters contain less than 6 months of data. With the special meter read being performed in September this 6 month period coincides with the period during which many canegrowers do not irrigate their crops rendering the files useless.

Of the interval data files obtained from Ergon only 10 contain more than 6 months of data.

The interval data was also obtained from canegrowers using a variety of irrigation methods. For this analysis only pivot and winch irrigation was required (so sites with Furrow Irrigation were to be ignored)

A summary of all files containing more than 6 months of data are shown in the following table.

NMI	Data Avail	File name	Irrig Type	Region
3033626847	>12Months	3033626847_91310455_LS1	Furrow	Burdekin
3041667174	>12Months	3041667174	Furrow	Bundaberg
3041667905	>12Months	3041667905	Furrow	Bundaberg
3042007054	>12Months	3042007054	Winch	Bundaberg
3052073629	>12Months	3052073629_91310276_ LS1	Furrow	Burdekin
QEEE7000713	>12Months	FT100_0010_Ft0010_20150909092547_91015349_ls1	Pivots and furrow	Tableland
30309955583	>12Months	FT100_0010_Ft0010_20150909092615_91122292_ls1	Pivot	Tableland
30310108738	>12Months	FT100_0010_Ft0010_20150909092625_91215749_ls1	Pivots and furrow	Tableland
3041666585	6-12Months	3041666585	Furrow	Bundaberg
3041667018	6-12Months	3041667018	Furrow	Bundaberg

The two useful interval data files are highlighted in the table and are analysed in the following sections.

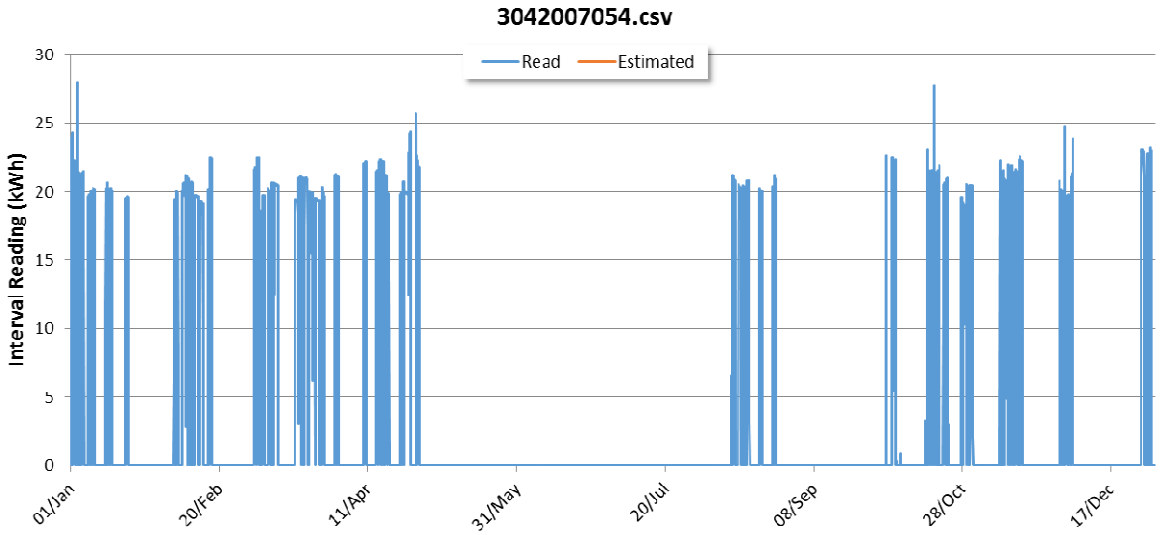
Processing

The required interval data files are to cover the 1st Jan 2016 to 31st Dec 2016. To achieve this the existing interval data is read and then copied to the closest date corresponding to the same day of the week). For example the specified year is a leap year so interval data for 29th Feb 2016 (a Monday) is copied from Monday 2nd March 2015.

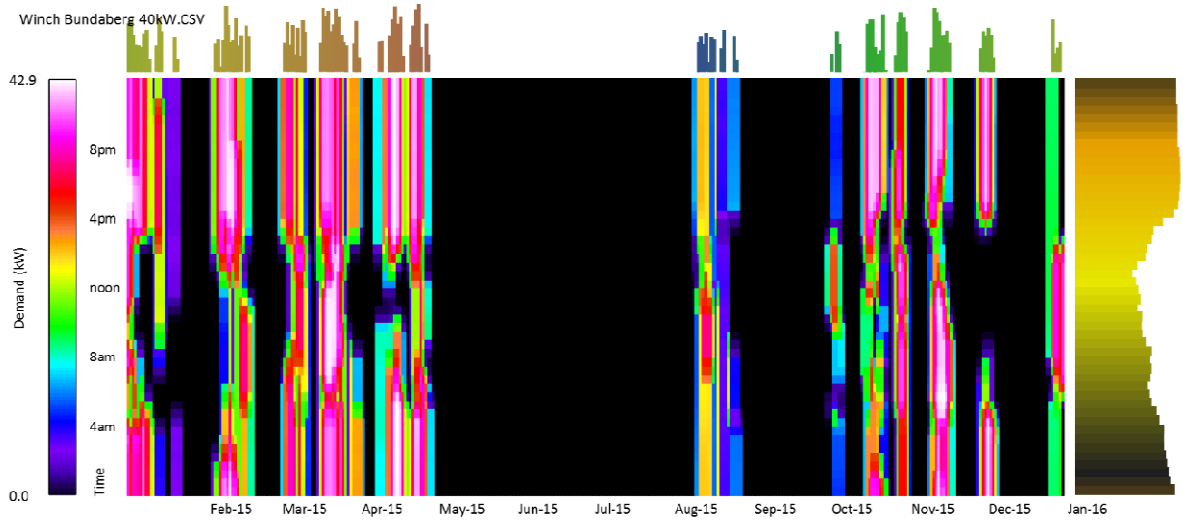
The program also allows the output to be scaled, clipped (to remove large unexplained demand peaks) and manually adjusted.

Bundaberg Winch (NMI 3042007054)

This site has a pump with a demand of 80kW. Most of the other sites appeared to use pumps with a demand of 40kW. The file was therefore scaled to a demand of 40kW.



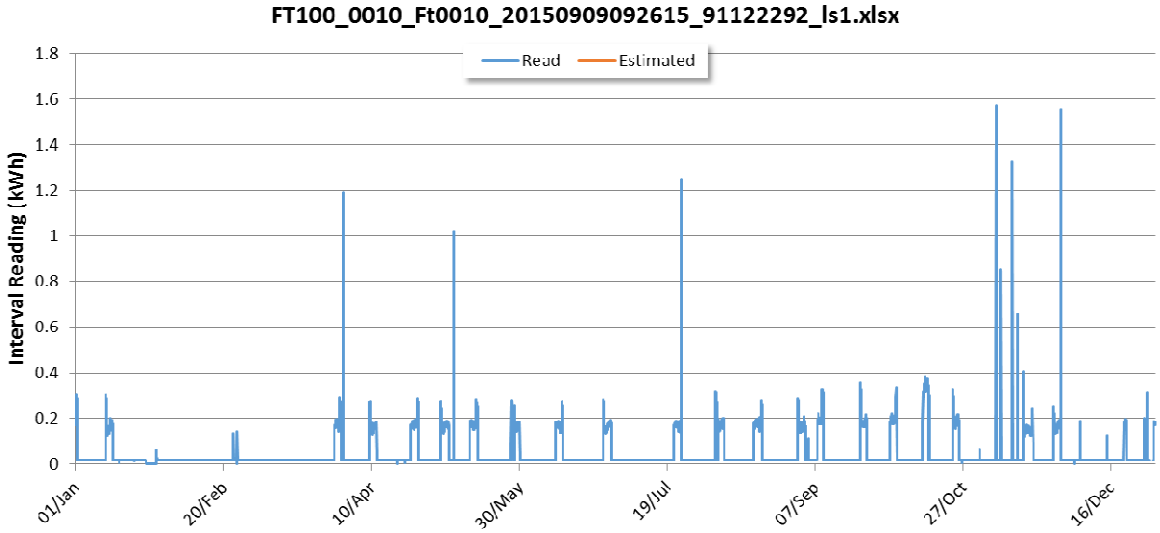
The file has been saved as Winch Bundaberg 40kW.csv. The heat plot for this file is shown below:



The pump run times for Winch Bundaberg 40kW.csv are show in Appendix A.

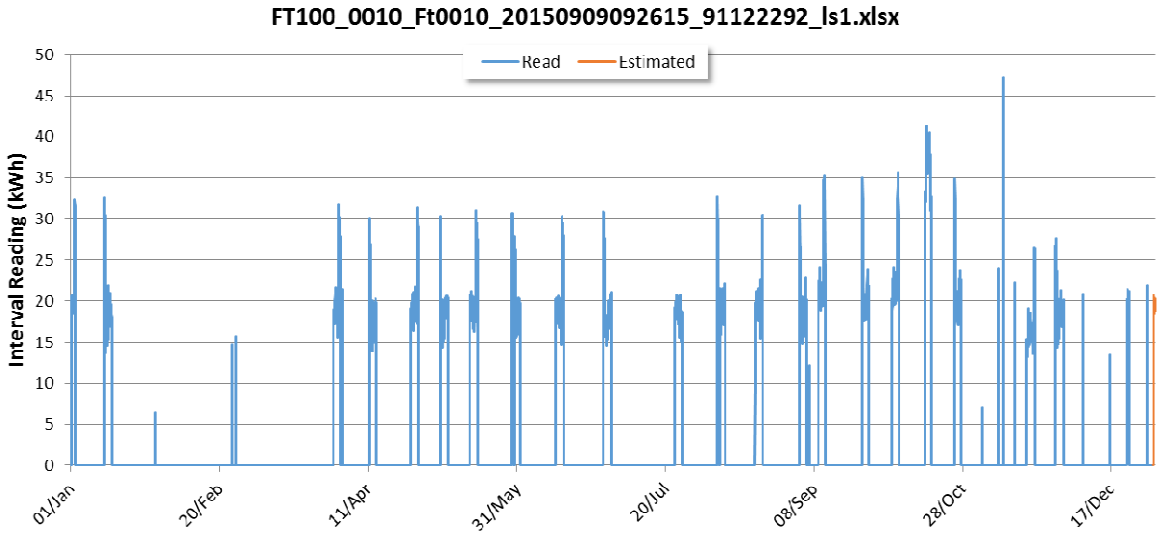
Two other pump sizes have also been provided corresponding to 11kW (Winch Bundaberg 11kW.csv) and 25kW (Winch Bundaberg 25kW.csv).

Pivot Tablelands (NMI 30309955583)
The raw data are shown in the following figure

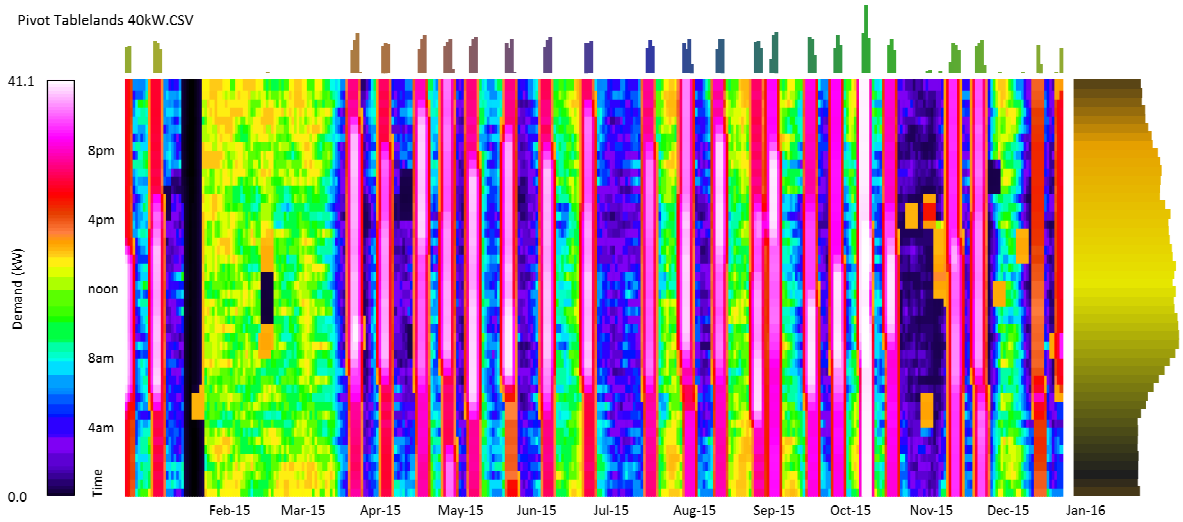


This file is suspicious for two reasons. Firstly the kWh demand is unrealistically low clearly there is an error in the entered transformer factor) and secondly the file shows significant large peaks.

The adjusted file therefore has been scaled to the assumed demand of 40kW and the suspiciously large peaks have been reduced. The final profile is shown below:



The file has been named Pivot Tablelands 40kW.csv. The heat plot for this file is shown below:



Note that the average daily profile shown on the right hand side of the heat plot indicates that irrigation starts in the morning and continues throughout the day (unlike winch irrigation which attempts to avoid windy periods in the middle of the day).

The pump switch times for Pivot Tablelands 40kW.csv are shown in Appendix A.

Two other pump sizes have been created Pivot Tablelands 11kW (an 11kW pump size) and Pivot Tablelands 25kW (a 25kW pump size).

Creating Simulated Interval Data Files
Based on Effective Water Deficit

Canegrowers have prepared a report "Irrigation Energy Cost Relationship". The report highlights the importance of using irrigation to recover the water deficit. Specifically canegrowers only irrigate when useful natural rainfall does not satisfy crop demand (reducing crop stress increases the yield).

A key table from the report shows average *EFFECTIVE* water deficit in the Bundaberg region. The effective water deficit takes into account varying crop needs throughout the growing season. It is emphasised that it is insufficient to look at average rainfall figures, since not all rainfall is useful, for example in a heavy downpour much of the rainfall runs off and does not contribute to soil moisture. The table from the report is shown below:

Farm monthly crop moisture demand Irrigation demand	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May
Average crop effective deficit (mm/mth)	-13	-34	-64	-70	-73	-49	-58	-50	-12

Creating simulated interval data files using the effective deficit

An Excel Macro has been written which enables the creation of irrigation pump interval data files. A simple model is used to convert the monthly effective water deficit into the pump runtimes. A number of parameters are used to convert the effective deficit into an interval data file.

The fundamental input to the simulated files is the effective average rainfall deficit. Since the interval data files are required to cover a full year the effective water deficit figures in the Bundaberg region for a full year become:

Bundaberg	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Effective Deficit (mm)	-73	-49	-58	-50	-12	0	0	0	-13	-34	-64	-70

The parameters used to convert the effective deficit into interval data were inferred from another table included in the Canegrowers report "Irrigation Energy Cost Relationship". Specifically their Scenario 1

1. Travelling irrigator operating 22 hrs per day during peak demand period (start 4.00 pm stop 2.00 pm next day) – crop stress days nil – maximises production

   Wind effect – strongest mid-afternoon 3.00 pm (partially avoided) – the system is shut down for 50% of highest wind period (1.00 – 5.00 pm daily)

   Current most suitable tariff 66

Ha per system	Operating hrs/day	Lane spacing (m)	Irrigated ha/day	Flow rate L/sec	ML/pumped per day	Rain eq (mm/irrig)	Irrigation cycle (days)	Avail moisture mm/day
30	22	75	3.0	25	1.98	65	10	6.5

The critical parameters are the Crop Area, Hours of Operation, Rate of Coverage and Flow Rate which were implemented in the Excel macro as shown in the following table:

Parameters	**Value**	**Unit**
Crop Area (per system)	30	Ha
Irrigation Cycle (min)	10	days
Flow Rate	25	litres/sec
Inefficiency	20%	
Pump Start Time	16:00	
Pump Stop Time	14:00	
Pump Demand	40	kW
Coverage Rate	0.136	Ha/hr
Random Start	60	minutes
Random Stop	120	minutes
Random Demand	5%	

Description of the parameters
"Crop Area" is the irrigated size of the Crop (in Hectares)

"Coverage Rate" is the speed of the irrigation system or the number of Hectares of the crop covered per hour.

These two figures allow the time for the irrigation system to cover the required crop area

$$Time\ To\ Water\ Whole\ Crop = \frac{Crop\ Area}{Coverage\ Rate}$$

Assumption: Each time irrigation is undertaken the Crop Area will be covered. Hence the total time the irrigation system is used each month with be an integral number of times multiplied by the Time to Water the Whole Crop.

Flow Rate is the number of litres delivered per second. This is used to calculate the Equivalent Rainfall per hour of operation of the irrigation system.

$$Equivalent\ Rainfall\ per\ hour = 0.36 \times \frac{Flow\ Rate}{Coverage\ Rate}$$

Pump Start Time and Pump Stop Time: Typically Canegrowers attempt to avoid particular times of the day. For example high winds in the middle of the day make winch irrigation much less effective, so irrigation during these hours is avoided.

$$Operating\ Hours\ per\ Day = Pump\ Stop\ Tme - Pump\ Start\ Time$$

Random Start and Random Stop: Pumps are typically manually started and stopped hence the actual start and stop time vary each time the pump is used. These parameters have been added to make the profiles more realistic. For example in the above table the parameters assume the pump may be started an hour either side of the start time and stopped 2 hours either side of the stop time.

Inefficiency: Not all the applied water is useful. The inefficiency factor is used to adjust the Monthly effective deficit to the Number of mm of water that must be applied to the crop.

$$Water\ Requirement\ = Effective\ Monthly\ Deficit\ x\ (1 + Inefficiency)$$

The above figures are sufficient to calculate the Average Gap Between Runs.

Total Hours (of irrigation) per Month

$$Total\ Hours\ Per\ Month = \frac{Time\ to\ Water\ Whole\ Crop\ \times Water\ Requirement}{Equivalent\ Rainfall\ per\ hour}$$

Number Of Times to Run per month

$$Number\ of\ Times\ to\ Run = \frac{Total\ Hours\ Per\ Month}{Operating\ Hours\ per\ Day}$$

Note the Number of Times to Run is always converted into the next largest integer value (Ceiling())

$$Average\ Gap\ Between\ Runs = \frac{Days\ In\ Month}{Number\ of\ Times\ To\ Run}$$

The first time the pump is turned on is the first day of the month + Average Gap Between Runs / 2

The other parameters scale the electricity usage for the installed pump size

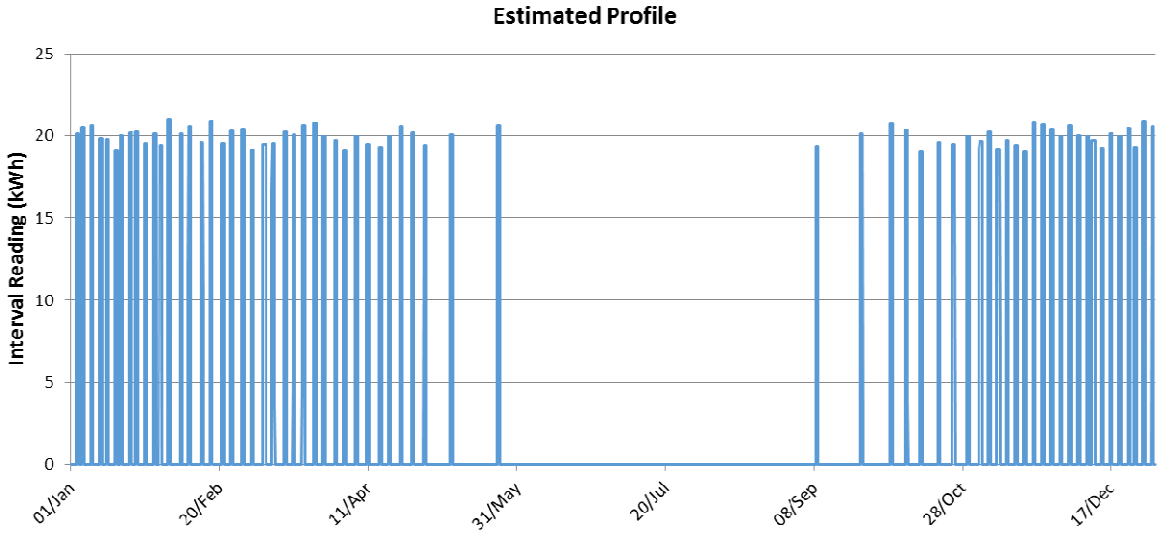
Pump Demand is the nominal rating of the pump (in kW)

Random Demand is used to vary the Pump Demand each time the pump is turned on

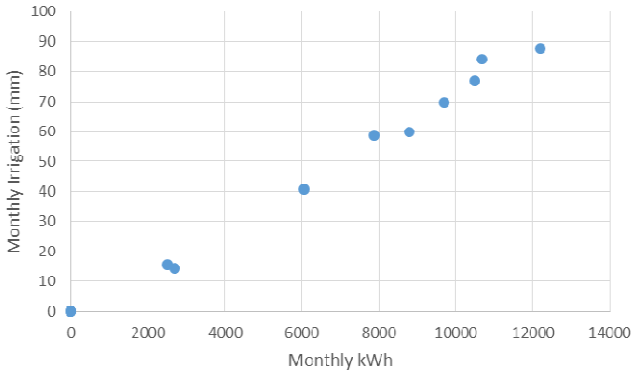
Irrigation Cycle (min) is not currently implemented. It is intended to limit the minimum Average Gap between Runs. (A similar result can be achieved by changing the monthly Rainfall deficit figure).

Example Simulated file

Using the effective deficit for Bundaberg and parameters shown above results in the profile

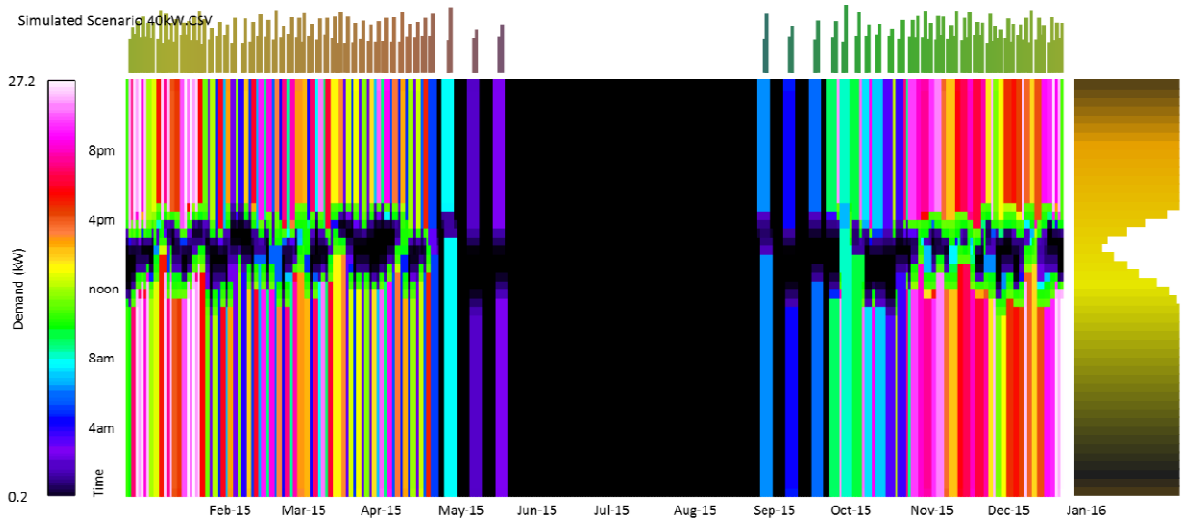


Creating the interval data profile based on the effective water requirements ensures that pump electricity use and water application are directly related. This is confirmed by plotting monthly irrigation target (in mm) again electricity use (in kWh).



The above interval data file has been saved as Simulated Scenario 40kW.csv. The corresponding pump turn on and off times are shown in Appendix A.

The heat plot for this file is



The V shape in the average daily profile shown on the right hand side corresponds to the avoided times of the day.

Comment on Algorithm Accuracy

The accuracy of the simulated files is directly related to the algorithm and input parameters.

It is clearly stated that both the algorithm and corresponding parameters were created by someone with no special knowledge of irrigation systems. Specifically it remains unclear how (or even if) the same simulation methodology can be used to create files representing pivot and winch operation.

Given the high level of uncertainty around the simulation methodology minimal error checking of the input parameters has been implemented. The entry of unreasonable input parameters results in program crashes and/or the production of unrealistic profiles.

Acknowledged Issues with the Simulation Methodology

Several parameters are reasonably linked. A larger pump is required to water larger Crop Areas.

It is unclear if installed irrigation systems provide adjustment of Flow Rate and Coverage Rate. Such adjustment would allow growers fine control of the effective amount of water applied each time the crop is irrigated. It is apparent that these parameters are also likely to be related to the pump size.

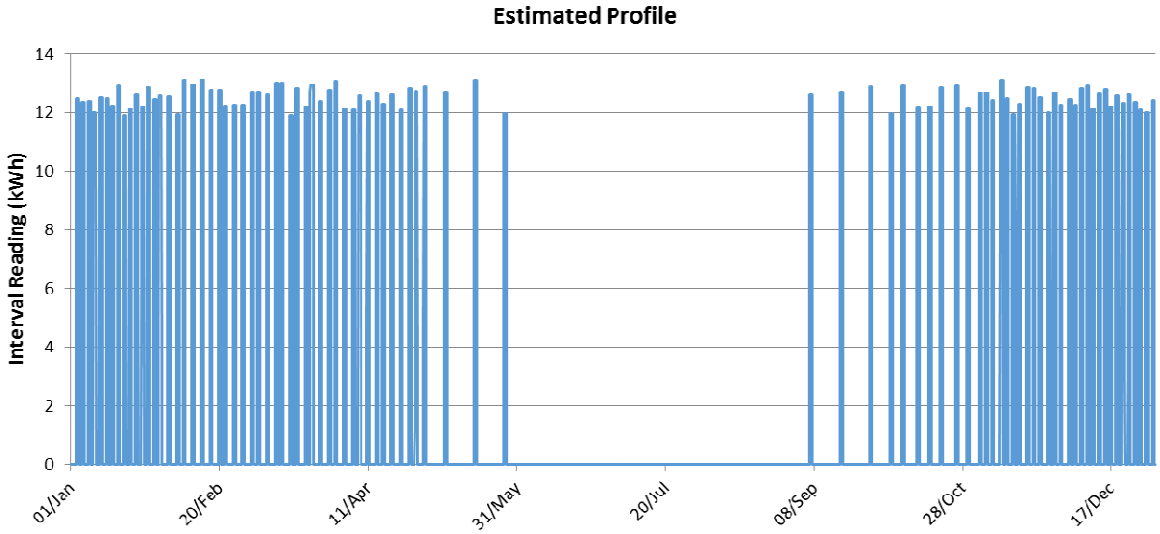
A request was received very late in the development to add the capability to simulate the response to particular tariffs. This has only been partially implemented. The Pump Start and Pump Stop times provide one means of adjusting pump use in response to tariffs. Several current tariffs also offer off peak rates for the entire weekend. The program does not currently support an option to run the pumps continuously over the weekend.

While not confirmed it has been assumed that the implemented algorithm is describing winch irrigation. This assumption is based on the need to avoid winch irrigation when windy, in the middle of the day. By contrast pivot irrigation appears to be run continuously.

Another Simulated File

Modifying the other parameters results in different profiles. For example an attempt at lowering the size of the pump (down to 25kW) has been simulated by reducing the flow rate and the size of the Crop Area (rightly or wrongly the Coverage Rate was left the same)

Parameters		
Crop Area (per system)	20	Ha
Irrigation Cycle (min)	10	days
Flow Rate	15	litres/sec
Inefficiency	20%	
Pump Start Time	17:00	
Pump Stop Time	13:00	
Pump Demand	25	kW
Coverage Rate	0.136	Ha/hr
Random Start	30	minutes
Random Stop	60	minutes
Random Demand	5%	



This file has been saved as Simulated Scenario 25kW.csv.

Creating a profile based on an automated system is also possible. When the pumps are started and stopped automatically then the Random Start and Random Stop time should be set to a small value.

Profiles for the Tablelands Region

Late in the development of the simulated profiles the effective water deficit for Cane crops in the Tablelands Region was provided. It is repeated here only for reference:

Tableland	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Effective Deficit (mm)	150	28	32	0	30	52	25	49	65	76	114	114

Create Pump Profiles from Start and Stop times

A second method was proposed to create interval data. This method uses pump start and stop times. The following table was included in the document "Pivot Tablelands.dox".

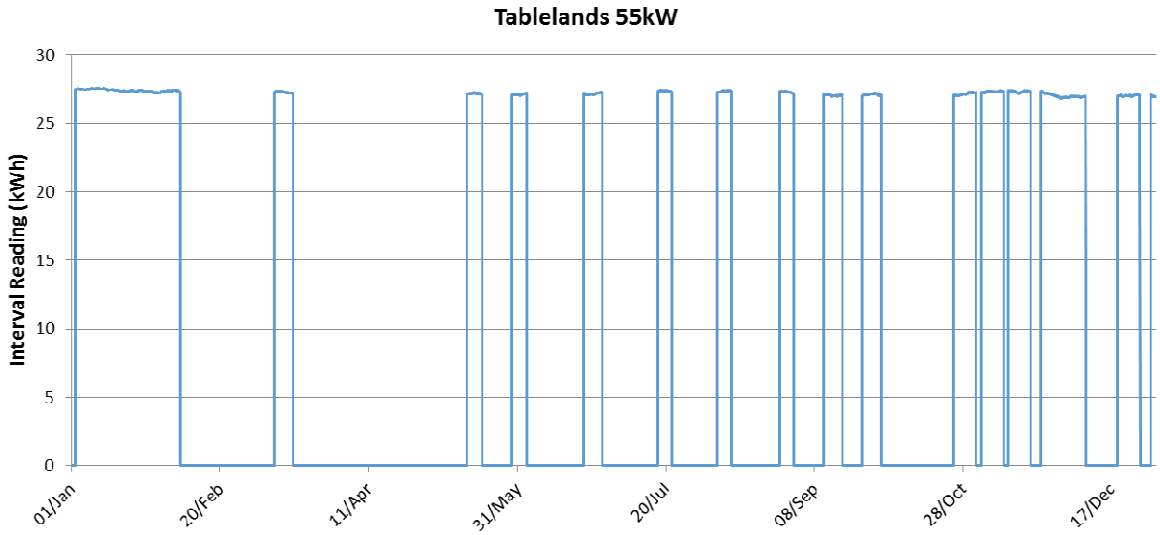
Pump Start Date	Start Time	Pump Stop Date	Stop Time	Water Applied (mm)
2/1/15	06:19	8/1/15	13:19	32
8/1/15	13:19	14/1/15	20:19	32
14/1/15	20:19	23/1/15	23:01	50
23/1/15	23:01	31/01/15	5:55	32
31/01/15	05:55	6/02/15	12:55	32
10/03/15	07:51	16/03/15	14:51	32
14/05/15	05:20	19/05/2015	04:20	25
29/05/15	06:46	03/06/15	05:46	25
22/06/15	07:50	28/06/15	14:50	32
17/07/15	06:23	22/07/15	05:23	25
06/08/15	05:08	11/08/15	04:08	25
27/08/15	06:51	01/09/15	05:51	25
11/09/15	06:50	17/09/15	13:50	32
24/09/15	05:25	30/09/15	12:25	32
17/10/15	06:27	24/09/15	20:27	38
24/10/15	20:27	1/11/15	10:27	38
03/11/15	07:12	10/11/15	21:12	38
12/11/15	5:09	19/11/15	19:09	38
23/11/15	05:46	30/11/15	19:46	38
30/11/15	19:46	08/12/15	9:46	38
19/12/15	05:22	26/12/15	19:22	38
30/12/15	05:19	06/01/16	19:19	38

Several of the pump stop times are the same as start times meaning that the pump was actually left on continuously (the longest continuous period was from the 2nd Jan to the 6th Feb).

A note in the accompanying email detailed the pump size for the above data:

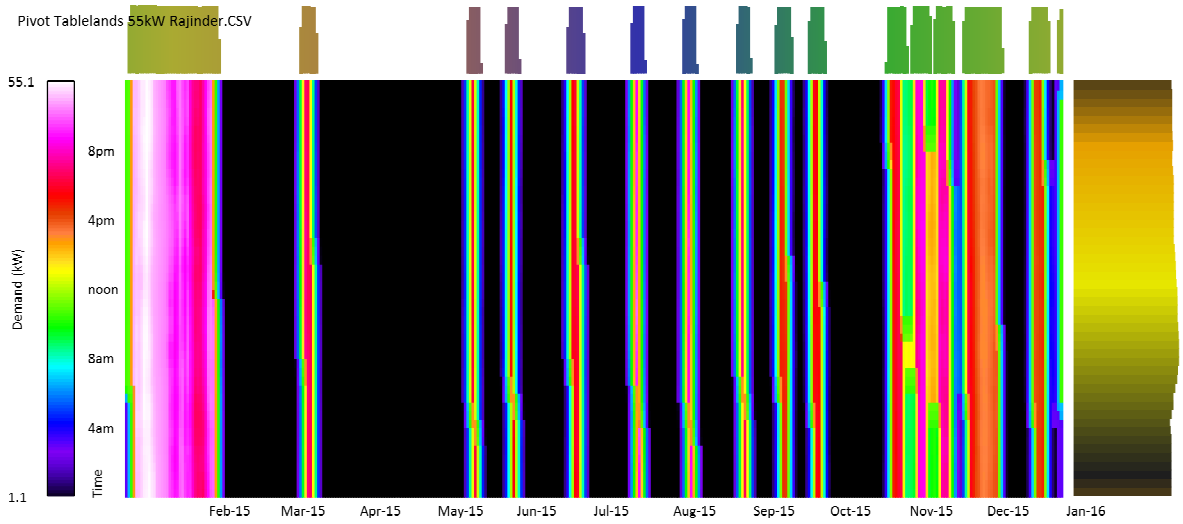
This pivot waters 80ha and uses a 25 kW water. This motor is smaller than what is typical for the Tableland because for this particular location the centre of the pivot is at the highest part of the paddock. A 55kW motor would be the most common size on the Tableland.

For this reason two files have been created from the table of start and stop times, one with a pump size of 25kW (Pivot Tablelands 25kW.csv) and the second with a pump size of 55kW (Pivot Tablelands 55kW.csv). The final profile for the 55kW pump is shown below.



Note that a small amount of randomisation has been applied to the half hourly pump demand to make the profile look more realistic.

The heat plot for this file is shown below:



Pump Run Times for files

A separate program will create a simulated profile from entered pump start and stop times. Analysis of the existing files shows the start and stop times.

Winch Bundaberg xxkW.csv

Thu, 01/Jan/2015	07:44	Thu, 01/Jan/2015	16:30
Thu, 01/Jan/2015	16:18	Fri, 02/Jan/2015	10:00
Fri, 02/Jan/2015	14:38	Sat, 03/Jan/2015	05:00
Sat, 03/Jan/2015	05:50	Sat, 03/Jan/2015	07:00
Sat, 03/Jan/2015	10:12	Sat, 03/Jan/2015	20:00
Sun, 04/Jan/2015	14:41	Mon, 05/Jan/2015	10:00
Tue, 06/Jan/2015	14:44	Wed, 07/Jan/2015	06:00
Wed, 07/Jan/2015	15:11	Thu, 08/Jan/2015	07:30
Thu, 08/Jan/2015	15:43	Fri, 09/Jan/2015	06:00
Mon, 12/Jan/2015	14:55	Tue, 13/Jan/2015	04:58
Tue, 13/Jan/2015	07:44	Tue, 13/Jan/2015	23:30
Wed, 14/Jan/2015	09:28	Thu, 15/Jan/2015	01:00
Mon, 19/Jan/2015	10:40	Tue, 20/Jan/2015	06:00
Wed, 04/Feb/2015	13:14	Thu, 05/Feb/2015	04:00
Thu, 05/Feb/2015	14:06	Fri, 06/Feb/2015	03:00
Sat, 07/Feb/2015	12:06	Mon, 09/Feb/2015	07:00
Mon, 09/Feb/2015	14:11	Tue, 10/Feb/2015	04:00
Tue, 10/Feb/2015	15:44	Wed, 11/Feb/2015	02:00
Wed, 11/Feb/2015	12:56	Thu, 12/Feb/2015	21:00
Fri, 13/Feb/2015	14:23	Sat, 14/Feb/2015	15:00
Mon, 16/Feb/2015	05:28	Mon, 16/Feb/2015	12:00
Mon, 16/Feb/2015	14:39	Tue, 17/Feb/2015	13:00
Tue, 03/Mar/2015	14:25	Wed, 04/Mar/2015	08:30
Wed, 04/Mar/2015	14:47	Thu, 05/Mar/2015	10:00
Fri, 06/Mar/2015	06:10	Sat, 07/Mar/2015	07:30
Sun, 08/Mar/2015	07:38	Mon, 09/Mar/2015	06:00
Mon, 09/Mar/2015	13:24	Mon, 09/Mar/2015	15:30
Tue, 10/Mar/2015	05:33	Wed, 11/Mar/2015	15:30
Tue, 17/Mar/2015	13:39	Thu, 19/Mar/2015	13:30
Thu, 19/Mar/2015	16:30	Fri, 20/Mar/2015	06:00
Fri, 20/Mar/2015	06:44	Fri, 20/Mar/2015	13:30
Fri, 20/Mar/2015	14:07	Sat, 21/Mar/2015	15:30
Sun, 22/Mar/2015	07:12	Tue, 24/Mar/2015	06:00
Tue, 24/Mar/2015	08:30	Wed, 25/Mar/2015	14:55
Thu, 26/Mar/2015	13:38	Fri, 27/Mar/2015	11:00
Mon, 30/Mar/2015	14:26	Tue, 31/Mar/2015	09:26
Tue, 31/Mar/2015	14:38	Wed, 01/Apr/2015	06:00
Thu, 09/Apr/2015	13:57	Fri, 10/Apr/2015	11:30
Mon, 13/Apr/2015	12:13	Tue, 14/Apr/2015	09:00
Tue, 14/Apr/2015	14:27	Wed, 15/Apr/2015	12:00
Wed, 15/Apr/2015	13:39	Thu, 16/Apr/2015	07:30
Thu, 16/Apr/2015	14:03	Fri, 17/Apr/2015	11:30
Fri, 17/Apr/2015	15:10	Sat, 18/Apr/2015	07:00
Tue, 21/Apr/2015	14:25	Wed, 22/Apr/2015	06:30
Wed, 22/Apr/2015	12:50	Thu, 23/Apr/2015	05:55
Thu, 23/Apr/2015	07:13	Sat, 25/Apr/2015	09:00
Mon, 27/Apr/2015	05:44	Mon, 27/Apr/2015	08:00
Mon, 27/Apr/2015	08:31	Mon, 27/Apr/2015	14:00
Mon, 27/Apr/2015	14:37	Tue, 28/Apr/2015	07:00
Tue, 11/Aug/2015	11:14	Tue, 11/Aug/2015	13:00
Tue, 11/Aug/2015	13:35	Wed, 12/Aug/2015	13:30
Thu, 13/Aug/2015	14:44	Fri, 14/Aug/2015	15:30
Sat, 15/Aug/2015	07:16	Sat, 15/Aug/2015	12:30
Sun, 16/Aug/2015	12:00	Mon, 17/Aug/2015	13:00

Thu, 20/Aug/2015	16:09	Fri, 21/Aug/2015	16:30
Tue, 25/Aug/2015	05:12	Tue, 25/Aug/2015	10:00
Tue, 25/Aug/2015	15:55	Wed, 26/Aug/2015	05:30
Fri, 02/Oct/2015	04:45	Fri, 02/Oct/2015	06:30
Fri, 02/Oct/2015	10:40	Fri, 02/Oct/2015	16:30
Sun, 04/Oct/2015	10:10	Mon, 05/Oct/2015	11:30
Thu, 15/Oct/2015	11:06	Thu, 15/Oct/2015	12:30
Fri, 16/Oct/2015	06:24	Fri, 16/Oct/2015	13:26
Fri, 16/Oct/2015	14:26	Sat, 17/Oct/2015	08:00
Sat, 17/Oct/2015	13:45	Sun, 18/Oct/2015	05:29
Sun, 18/Oct/2015	11:58	Mon, 19/Oct/2015	01:30
Mon, 19/Oct/2015	15:46	Tue, 20/Oct/2015	03:00
Tue, 20/Oct/2015	05:17	Tue, 20/Oct/2015	09:25
Wed, 21/Oct/2015	16:25	Thu, 22/Oct/2015	07:30
Thu, 22/Oct/2015	07:41	Thu, 22/Oct/2015	15:30
Thu, 22/Oct/2015	16:36	Fri, 23/Oct/2015	01:30
Fri, 23/Oct/2015	10:06	Fri, 23/Oct/2015	11:30
Tue, 27/Oct/2015	14:11	Tue, 27/Oct/2015	21:00
Wed, 28/Oct/2015	04:47	Thu, 29/Oct/2015	15:30
Thu, 29/Oct/2015	16:07	Fri, 30/Oct/2015	10:30
Fri, 30/Oct/2015	10:39	Fri, 30/Oct/2015	15:00
Fri, 30/Oct/2015	16:29	Sat, 31/Oct/2015	15:25
Mon, 09/Nov/2015	16:47	Mon, 09/Nov/2015	18:00
Tue, 10/Nov/2015	15:58	Wed, 11/Nov/2015	05:30
Wed, 11/Nov/2015	05:37	Thu, 12/Nov/2015	13:00
Thu, 12/Nov/2015	15:47	Fri, 13/Nov/2015	02:00
Fri, 13/Nov/2015	04:06	Fri, 13/Nov/2015	15:55
Fri, 13/Nov/2015	17:57	Sat, 14/Nov/2015	08:00
Sat, 14/Nov/2015	10:10	Sat, 14/Nov/2015	13:00
Sat, 14/Nov/2015	19:33	Sun, 15/Nov/2015	14:00
Mon, 16/Nov/2015	04:51	Mon, 16/Nov/2015	12:00
Mon, 16/Nov/2015	16:29	Tue, 17/Nov/2015	11:00
Sun, 29/Nov/2015	15:11	Mon, 30/Nov/2015	08:30
Mon, 30/Nov/2015	17:12	Tue, 01/Dec/2015	06:00
Tue, 01/Dec/2015	15:23	Wed, 02/Dec/2015	10:00
Wed, 02/Dec/2015	16:17	Thu, 03/Dec/2015	06:00
Thu, 03/Dec/2015	16:06	Fri, 04/Dec/2015	06:00
Sun, 27/Dec/2015	07:15	Mon, 28/Dec/2015	07:00
Tue, 29/Dec/2015	06:14	Tue, 29/Dec/2015	15:30
Wed, 30/Dec/2015	06:19	Wed, 30/Dec/2015	16:00
Fri, 30/Dec/2016	16:18	Sat, 31/Dec/2016	05:30
Sat, 31/Dec/2016	14:47		

Pivot Tablelands xxkW.csv

Thu, 01/Jan/2015	06:19	Fri, 02/Jan/2015	15:29
Mon, 12/Jan/2015	05:55	Wed, 14/Jan/2015	17:59
Thu, 29/Jan/2015	05:08	Thu, 29/Jan/2015	06:29
Tue, 24/Feb/2015	08:48	Tue, 24/Feb/2015	09:59
Wed, 25/Feb/2015	09:19	Wed, 25/Feb/2015	10:30
Wed, 25/Feb/2015	13:49	Wed, 25/Feb/2015	14:59
Mon, 30/Mar/2015	07:51	Wed, 01/Apr/2015	22:29
Thu, 02/Apr/2015	09:14	Thu, 02/Apr/2015	10:59
Sat, 11/Apr/2015	07:22	Mon, 13/Apr/2015	20:59
Sat, 25/Apr/2015	06:46	Mon, 27/Apr/2015	23:29
Tue, 05/May/2015	07:50	Fri, 08/May/2015	03:29
Fri, 15/May/2015	05:20	Sun, 17/May/2015	20:29
Fri, 29/May/2015	06:43	Fri, 29/May/2015	21:59
Sat, 30/May/2015	06:23	Mon, 01/Jun/2015	01:29
Sat, 13/Jun/2015	05:08	Mon, 15/Jun/2015	20:59

Mon, 29/Jun/2015	06:51	Wed, 01/Jul/2015	23:29
Thu, 23/Jul/2015	06:51	Sat, 25/Jul/2015	20:59
Thu, 06/Aug/2015	08:25	Fri, 07/Aug/2015	00:59
Fri, 07/Aug/2015	06:27	Sun, 09/Aug/2015	06:59
Wed, 19/Aug/2015	07:12	Fri, 21/Aug/2015	22:29
Thu, 03/Sep/2015	05:09	Sat, 05/Sep/2015	17:59
Sun, 06/Sep/2015	15:45	Sun, 06/Sep/2015	16:59
Wed, 09/Sep/2015	15:21	Fri, 11/Sep/2015	21:29
Thu, 24/Sep/2015	05:46	Sat, 26/Sep/2015	12:29
Sun, 04/Oct/2015	07:39	Tue, 06/Oct/2015	14:29
Thu, 15/Oct/2015	08:26	Sat, 17/Oct/2015	11:29
Sat, 17/Oct/2015	11:43	Sat, 17/Oct/2015	12:59
Sat, 17/Oct/2015	12:56	Sat, 17/Oct/2015	16:29
Sun, 25/Oct/2015	09:23	Tue, 27/Oct/2015	15:29
Tue, 03/Nov/2015	16:08	Tue, 03/Nov/2015	17:29
Mon, 09/Nov/2015	04:46	Mon, 09/Nov/2015	06:29
Tue, 10/Nov/2015	17:00	Tue, 10/Nov/2015	17:59
Sat, 14/Nov/2015	12:16	Sat, 14/Nov/2015	14:29
Wed, 18/Nov/2015	13:45	Sat, 21/Nov/2015	15:59
Sat, 28/Nov/2015	07:21	Tue, 01/Dec/2015	06:59
Mon, 07/Dec/2015	11:56	Mon, 07/Dec/2015	12:59
Wed, 16/Dec/2015	14:17	Wed, 16/Dec/2015	15:59
Tue, 22/Dec/2015	05:22	Wed, 23/Dec/2015	07:29
Tue, 29/Dec/2015	08:57	Tue, 29/Dec/2015	09:59
Thu, 31/Dec/2015	06:19		

Simulated Scenario 40kW.csv

Fri, 02/Jan/2015	15:33	Sat, 03/Jan/2015	13:00
Sun, 04/Jan/2015	15:11	Mon, 05/Jan/2015	13:30
Tue, 06/Jan/2015	16:19	Wed, 07/Jan/2015	15:00
Thu, 08/Jan/2015	14:37	Fri, 09/Jan/2015	13:30
Sat, 10/Jan/2015	15:48	Sun, 11/Jan/2015	14:30
Tue, 13/Jan/2015	16:23	Wed, 14/Jan/2015	16:30
Thu, 15/Jan/2015	16:20	Fri, 16/Jan/2015	16:00
Sat, 17/Jan/2015	15:43	Sun, 18/Jan/2015	13:30
Mon, 19/Jan/2015	15:40	Tue, 20/Jan/2015	15:00
Thu, 22/Jan/2015	14:36	Fri, 23/Jan/2015	13:30
Sat, 24/Jan/2015	15:16	Sun, 25/Jan/2015	14:00
Mon, 26/Jan/2015	16:47	Tue, 27/Jan/2015	14:30
Wed, 28/Jan/2015	16:46	Thu, 29/Jan/2015	16:00
Fri, 30/Jan/2015	16:27	Sat, 31/Jan/2015	15:00
Mon, 02/Feb/2015	15:21	Tue, 03/Feb/2015	12:30
Thu, 05/Feb/2015	14:49	Fri, 06/Feb/2015	14:00
Sun, 08/Feb/2015	15:03	Mon, 09/Feb/2015	13:00
Wed, 11/Feb/2015	16:33	Thu, 12/Feb/2015	15:30
Sun, 15/Feb/2015	16:23	Mon, 16/Feb/2015	15:00
Wed, 18/Feb/2015	16:52	Thu, 19/Feb/2015	14:00
Sat, 21/Feb/2015	15:57	Sun, 22/Feb/2015	15:30
Tue, 24/Feb/2015	15:29	Wed, 25/Feb/2015	14:00
Fri, 27/Feb/2015	16:07	Sat, 28/Feb/2015	16:30
Mon, 02/Mar/2015	15:54	Tue, 03/Mar/2015	13:00
Thu, 05/Mar/2015	15:28	Fri, 06/Mar/2015	14:30
Sun, 08/Mar/2015	15:50	Mon, 09/Mar/2015	15:00
Tue, 10/Mar/2015	16:42	Wed, 11/Mar/2015	16:30
Fri, 13/Mar/2015	15:08	Sat, 14/Mar/2015	13:30
Mon, 16/Mar/2015	15:39	Tue, 17/Mar/2015	14:30
Thu, 19/Mar/2015	14:53	Fri, 20/Mar/2015	14:30
Sun, 22/Mar/2015	15:55	Mon, 23/Mar/2015	16:00
Tue, 24/Mar/2015	17:27	Wed, 25/Mar/2015	15:59

Fri, 27/Mar/2015	16:21	Sat, 28/Mar/2015	16:00
Mon, 30/Mar/2015	16:31	Tue, 31/Mar/2015	13:27
Thu, 02/Apr/2015	15:22	Fri, 03/Apr/2015	14:30
Sun, 05/Apr/2015	16:07	Mon, 06/Apr/2015	13:29
Wed, 08/Apr/2015	16:24	Thu, 09/Apr/2015	14:00
Sat, 11/Apr/2015	16:23	Sun, 12/Apr/2015	14:30
Tue, 14/Apr/2015	16:35	Wed, 15/Apr/2015	15:00
Fri, 17/Apr/2015	16:52	Sat, 18/Apr/2015	16:30
Mon, 20/Apr/2015	14:42	Tue, 21/Apr/2015	13:30
Thu, 23/Apr/2015	14:51	Fri, 24/Apr/2015	14:30
Sun, 26/Apr/2015	14:40	Mon, 27/Apr/2015	15:00
Wed, 29/Apr/2015	14:45	Thu, 30/Apr/2015	16:00
Wed, 06/May/2015	16:58	Thu, 07/May/2015	17:00
Sat, 16/May/2015	14:45	Sun, 17/May/2015	12:30
Tue, 26/May/2015	14:51	Wed, 27/May/2015	13:30
Sun, 06/Sep/2015	16:14	Mon, 07/Sep/2015	16:00
Wed, 16/Sep/2015	14:40	Thu, 17/Sep/2015	13:00
Sat, 26/Sep/2015	16:10	Sun, 27/Sep/2015	13:57
Sat, 03/Oct/2015	16:18	Sun, 04/Oct/2015	13:30
Wed, 07/Oct/2015	16:15	Thu, 08/Oct/2015	17:30
Mon, 12/Oct/2015	15:21	Tue, 13/Oct/2015	15:25
Fri, 16/Oct/2015	15:56	Sat, 17/Oct/2015	13:00
Tue, 20/Oct/2015	15:24	Wed, 21/Oct/2015	13:00
Sun, 25/Oct/2015	15:01	Mon, 26/Oct/2015	12:30
Thu, 29/Oct/2015	15:22	Fri, 30/Oct/2015	14:26
Mon, 02/Nov/2015	15:29	Tue, 03/Nov/2015	14:00
Wed, 04/Nov/2015	15:21	Thu, 05/Nov/2015	15:30
Sat, 07/Nov/2015	15:21	Sun, 08/Nov/2015	16:30
Mon, 09/Nov/2015	16:23	Tue, 10/Nov/2015	13:30
Thu, 12/Nov/2015	16:59	Fri, 13/Nov/2015	15:00
Sat, 14/Nov/2015	15:51	Sun, 15/Nov/2015	15:00
Tue, 17/Nov/2015	15:47	Wed, 18/Nov/2015	13:26
Thu, 19/Nov/2015	15:48	Fri, 20/Nov/2015	15:57
Sun, 22/Nov/2015	16:07	Mon, 23/Nov/2015	15:30
Tue, 24/Nov/2015	16:27	Wed, 25/Nov/2015	16:00
Fri, 27/Nov/2015	15:05	Sat, 28/Nov/2015	14:00
Sun, 29/Nov/2015	15:11	Mon, 30/Nov/2015	13:30
Wed, 02/Dec/2015	17:27	Thu, 03/Dec/2015	16:00
Fri, 04/Dec/2015	15:59	Sat, 05/Dec/2015	13:30
Sun, 06/Dec/2015	15:47	Mon, 07/Dec/2015	12:30
Wed, 09/Dec/2015	15:18	Thu, 10/Dec/2015	14:26
Fri, 11/Dec/2015	16:49	Sat, 12/Dec/2015	13:30
Mon, 14/Dec/2015	15:14	Tue, 15/Dec/2015	13:00
Wed, 16/Dec/2015	16:22	Thu, 17/Dec/2015	15:00
Fri, 18/Dec/2015	16:20	Sat, 19/Dec/2015	16:30
Mon, 21/Dec/2015	15:15	Tue, 22/Dec/2015	15:30
Wed, 23/Dec/2015	15:14	Thu, 24/Dec/2015	13:00
Sat, 26/Dec/2015	16:11	Sun, 27/Dec/2015	15:00
Mon, 28/Dec/2015	16:49	Tue, 29/Dec/2015	13:30
Wed, 30/Dec/2015	16:27	Thu, 31/Dec/2015	13:30